Sediment Control BMPs

Uncontrolled runoff from construction sites is a water quality concern because of the devastating effects that sedimentation has on local water bodies, particularly small streams. Numerous studies show that the amount of sediment transported by storm water runoff from construction sites with no controls is significantly greater than from sites with controls. In addition to sediment, construction activities yield pollutants such as pesticides, petroleum products, construction chemicals, solvents, asphalts, and acids that contaminate storm water runoff. During storm events, construction sites are a source of sediment-laden runoff, which can overwhelm a small stream channel's capacity, resulting in streambed scour, streambank erosion, and destruction of near stream vegetative cover. Where left uncontrolled, sediment-laden runoff causes the loss of in-stream habitats for fish and other aquatic species, an increased difficulty in filtering drinking water, the loss of drinking water reservoir storage capacity, and negative impacts on the navigational capacity of waterways.

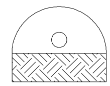
Polluted storm water runoff from construction sites often flows to Municipal Separate Storm Sewers (MS4s) and ultimately is discharged into local rivers and streams. Sediment is one of the main pollutant of concern. Sediment runoff rates from construction sites are typically 10 to 20 times greater than those of agricultural lands, and 1,000 to 2,000 times greater than those of forest lands. During a short period of time, construction sites have the potential to contribute more sediment to streams than is deposited naturally during several decades. The resulting siltation, and the contribution of other pollutants from construction sites, causes physical, chemical, and biological harm to our nation's waters. For example, excess sediment can quickly fill rivers and lakes, requiring dredging and destroying aquatic habitats.

There are numerous methods available to assist in the control of sediment. The following sediment control BMPs are discussed in this handbook:

- Temporary Sediment Basin
- Temporary Sediment Trap
- Silt Fence
- Rock Check Dams
- Sediment Tubes
- Stabilized Construction Entrances
- Storm Drain Inlet Protection
- Rock Sediment Dikes

Sediment Basin

Plan Symbol



Description

A Sediment Basin collects and traps sediment laden runoff from disturbed areas and slows down the flow so that soil particles fall from suspension and deposit in the basin. Drop inlet spillways, pipe spillways, rock fill outlets and weir spillways may be used for the design of the principal spillway.

When and Where to Use It

Temporary sediment basins are designed to have an 80 percent design removal efficiency goal for total suspended solids (TSS) or 0.5 mL/L peak settleable concentration, whichever is less. on sites where 10 or more acres are disturbed and drain to a single outlet point. A temporary sediment basin should not be built in wetlands, any active or live streams, ephemeral streams, or in Waters of State (defined to be all annual or perennial water bodies designated by a solid or dashed blue-line on USGS 7.5-minute quadrangle maps). Utilize temporary sediment basins until the contributing flow areas to the basin have undergone final stabilization.

Sediment Basin Design Criteria

Safety

Follow the design criteria such as those used by the USDA Soil Conservation Service (previously the Natural Resources Conservation Service), U.S. Army Corps of Engineers and the Dam Safety regulations.

Incorporate all possible safety precautions for ponds that are readily accessible to populated areas such as signs and fencing. The recommended inside pond slopes is 3H:1V with a 2H:1V maximum.

Design Aids

The Design Aids located in this section may be used to properly size sediment basins. Sedimot III, SEDCAD4 and other computer models that utilize eroded particle size distributions to calculate a corresponding trapping efficiency may also be utilized.

Riser Structure Design

Design the outlet riser to meet the discharge capacity of the 10-year 24-hour storm event.

General Design Requirements

a. Minimum drainage area - 5 acres
b. Maximum drainage area - 150 acres
c. 80 percent design removal efficiency goal for TSS.
d. The required draw down time of the basin is the time to detain flows to meet the 80 percent design removal goal. In many cases this will result in a draw down time longer than 36 hours. The maximum draw down time is 72 hours.

e. Basin Shape - Where applicable the effective flow length is at least twice the effective flow width . **(L = 2W minimum).**

f. Account for the sediment storage volume.

g. Outlet Riser and Barrel Requirements
   1. Discharge capacity - 10-year 24-hour storm event.
   2. Minimum outlet pipe diameter of 8-inches.
   3. Required 6-inch low flow orifice at bottom of riser structure.
   4. 2-year and 10-year 24-hour storm disturbed flow rates are ≤ to the pre-disturbance peak flow rates.
   5. Anti-vortex device / trash rack required.
   6. Minimum one-foot elevation difference from the top of riser to the crest of the emergency spillway.
   7. Sediment volume storage accounted for in design volume.

h. Embankment Requirements
   1. Maximum upstream slope – 2H:1V.
   2. Maximum downstream slope – 2H:1V.
   3. Freeboard - 12 inch minimum.
   4. Antiseep collars are required on all penetrations through the dam.

Inspection and Maintenance

The key to a functional sediment basin is continual monitoring, regular maintenance and regular sediment removal. Attention to sediment accumulations within the pond is extremely important. Continually monitor sediment deposition in the basin. Owners and maintenance authorities should be aware that significant concentrations of heavy metals (e.g., lead, zinc, and cadmium) as well as some organics such as pesticides, may be expected to accumulate at the bottom of these treatment facilities.

- Remove sediment when it reaches 50 percent of storage volume or reaches the top of the designed cleanout stake where applicable.
- Remove all temporary sediment basins within 30 days after final site stabilization is achieved or after it is no longer needed.
- Remove trapped sediment from the site , or stabilize on site.
- Permanently stabilize disturbed areas resulting from the removal of the sediment basin.

Sediment Basin Design Aids

Each soil type has an eroded particle diameter. See Appendix E. This data is required to determine the settling velocity of the particle, V_{15}. Figure SV-1 plots eroded particle diameter, d_{15}, versus settling velocity. Use this figure to determine the value of V_{15}. Use the basin ratio shown in the formula below to determine trapping efficiency. Figures SB-1 and SB-2 plot trapping efficiency versus the basin ratio. The basin ratio should be less than or equal to the curve value at any given trapping efficiency. The figures depicting trapping efficiency values are for the following two separate conditions:

- SB -1,basins **not** located in low lying areas and/or not having a high water table, and
- SB-2, basins located in low lying areas and/or having a high water table.

$$\text{Basin Ratio} = \frac{q_{po}}{A\,V_{15}}$$

Where:

q_{po} = Peak outflow rate from the basin for the 10-year 24-hour storm event (cfs),
A = Surface area of the pond at riser crest (acres),
V_{15} = Characteristic settling velocity (fps) of the characteristic D_{15} eroded particle (mm).

D_{15} is read from the tables in Appendix E, or is determined from a site specific soil eroded particle size distribution analysis. Never use the primary particle size distribution.

V_{15} is calculated or read from Figure SV1.

Constraints for use of Sediment Basin Design Aids:

- Watershed area less than or equal to 30 acres
- Overland slope less than or equal to 20 percent
- Outlet diameter less than or equal to 6-feet
- Basin Ratios above the design curves are not recommended for any application of the design aids. If the basin ratio q_{po}/AV_{15} intersects the curve at a point having a trapping efficiency less than the desired value, the design is inadequate and must be revised.

- A basin **not** located in a low lying area and not having a high water table, has a basin ratio equal to 2.20 E5 at 80 percent trapping efficiency as shown in Figure SB1.

- A basin that **is** located in a low lying area or in an area that has a high water table, has a basin ratio equal to 4.70 E3 at 80 percent trapping efficiency as shown in Figure SB2.

Sediment Basin Design Example

Given: Construct a sediment basin on a 14-acre (0.0219 mi^2) disturbed site.
The site is not located in a low lying area and does not have a high water table.
Peak discharge is limited to that of the current land use, established grass.
A pond site is available with an area at the riser crest of 0.75 ac.
Soil in the area is an Edisto with a Hydrologic Soil Group Type C.

Find: Trapping efficiency for a 10-year, 24-hour Type II storm if time of concentration is 20 minutes.

Solution:

1. Estimate the peak runoff allowed. The SCS curve number is found for a hydrologic soil group C with established grass as 74. Using a 10-year, 24-hour design storm of 6.0-inches, with this curve number yields a runoff volume of 3.2-inches using the SCS curve number method.

2. Using the SCS graphical method to estimate peak flow, the I_a/P ratio computes to approximately 0.12. Combining this and an estimated time of concentration equal to 0.33 hrs yields a q_u = 650 csm/in for a Type II storm distribution.

3. The peak discharge allowed is calculated by multiplying q_u times the runoff volume times the disturbed area in mi^2 and is approximately 46 cfs.

4. D_{15} for an Edisto sub-soil 0.0128. Using this diameter, V_{15} is estimated from Figure SV-1 as 3.7E-4 ft/sec.

5. The sediment basin ratio can now be calculated by calculating

$$q_{po} / (AV_{15}) = 46 / [(0.75)(3.7E\text{-}4)] = 1.70\ E5$$

6. Using Sediment Basin Design Aid (Figure SB-1) with this sediment basin ratio, read across to the curve and then turn down to the x-axis. The trapping efficiency is estimated to be 81%.

7. If the desired trapping efficiency was not obtained, the process would need to be repeated with a larger basin or decreased discharge until the desired trapping efficiency was found.

Temporary Sediment Basin

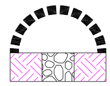
Temporary Sediment Basin Perforated Riser

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Outlet pipe is clogged with the debris.	Clean outlet pipe. Install a trash rack around pipe to hold back larger debris particles.
Spillway erodes due to high velocity flows.	Stabilize outlet with an ECB, TRM or riprap.
Side Slope eroding.	Stabilize slopes with vegetation, ECB, TRM, riprap or equivalent method.
Excessive accumulated sediment buildup.	Remove sediment to maintain the sediment storage capacity.
The upstream drainage area is too large.	Limit the contributing drainage area or expand basin. Ensure drainage area does not exceed recommended acreage. If the drainage area does exceed this limit, install diversion ditches and add additional BMPs to accommodate the diverted flow.

Sediment Trap

Plan Symbol



Description

A sediment trap is formed by excavating a pond or by placing an earthen embankment across a low area or drainage swale. An outlet or spillway is constructed using stones or aggregate to slow the release of runoff. The trap retains the runoff long enough to allow most of the silt to settle out. Design sediment traps to have an 80 percent design removal efficiency goal of the total suspended solids (TSS) in the inflow.

When and Where to Use It

A sediment trap may be formed completely by excavation or by construction of a compacted embankment. The outlet should be a rock fill weir/spillway section, with the area below the weir acting as a filter for sediment and the upper area as the overflow spillway depth. Temporary sediment traps should not be placed in Waters of the State or USGS blue-line streams (unless approved by SCDHEC, State, or Federal authorities).

Sediment Trap Design Criteria

To complete the design of the temporary sediment trap:

- Determine the required sediment storage volume.
- Determine the bottom and top surface area of the sediment storage volume using 3H:1V side slope from the bottom of the trap.
- Determine the total trap dimensions by adding the depth required for the 10-year, 24-hour design storm above the surface of the sediment storage volume, while not exceeding 2H:1V side slopes. Side slopes of 3H:1V are recommended, with a maximum of 2H:1V.
- Design temporary sediment traps with a minimum storage capacity of 1800 cubic feet of storage for each acre draining to them, regardless of the calculated trapping efficiency.

Design Aids

The Design Aids located in this section may be used to properly size sediment traps. Sedimot III, SEDCAD4, and other computer models that utilize eroded particle size distributions and calculates a corresponding trapping efficiency may also be utilized.

General Design Requirements

a. Maximum Drainage Area - 5 acres
b. Maximum Design Life - 18 months
c. 80 percent design removal efficiency goal for TSS
d. Basin Shape - The flow length is 2 times the flow width.
e. Embankment Requirements:
   1. Maximum dam height: 5-feet.
   2. Maximum stone height: 3.5-feet.
   3. Minimum rock bottom width: 3-feet.
   4. Discharge and treatment capacity for the 10-year 24-hour storm event.

Installation

Install a non-woven geotextile filter fabric before installing the stone for the outlet structure. Allow the stone to extend downstream past the toe of the embankment. Mark the sediment cleanout level of trap with a stake in the field. Seed and mulch all disturbed areas.

Inspection and Maintenance

The key to a functional sediment trap is continual monitoring, regular maintenance and regular sediment removal.

- Remove sediment when it reaches 50 percent of storage volume or top of cleanout stake.
- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- Remove all temporary sediment traps within 30 days after final site stabilization is achieved or after it is no longer needed.
- Remove trapped sediment from the site, or stabilized on site.
- Permanently stabilized disturbed areas resulting from the removal of sediment traps.

Sediment Trap Design Aids

The sediment trap design aid is a single line grouping all soil textures together. For the sediment trap, the ratio is:

$$\text{Sediment Trap Ratio} = \frac{q_{po}}{A\,V_{15}}$$

Where

q_{po} = Peak outflow for the 10-year 24-hour storm event (cfs)
A = Surface area at the elevation equal to the bottom of the rock fill outlet (acres)
V_{15} = Characteristic settling velocity (fps), of the characteristic D_{15} eroded particle (mm).

Read D_{15} is read Figure ST-1, or determine from a site specific soil eroded particle size distribution analysis. Never use the primary particle size distribution.

Read V_{15} from Figure SV1.

Constraints for the use of Sediment Trap Design Aids are:

- Watershed area less than or equal to 5 acres
- Overland slope less than or equal to 20 percent
- Rock fill diameter greater than 0.2-feet and less than 0.6-feet
- Rock fill height less than 5-feet
- Top width of rock fill between 2- and 4-feet
- Maximum Side slopes 1:1 to 1.5:1.

Sediment Trap Ratios above the design curves are not recommended for any application of the design aids. If the sediment trap ratio intersects the curve at a point having a trapping efficiency less than the desired value, the design is inadequate and must be revised.

A sediment trap ratio equal to 9.0 E4 has an 80 percent trapping efficiency

Route storm flows through sediment traps to calculate the required depth and storage volume of the trap.

Calculate a sediment storage volume and provide this volume below the bottom of the rock fill outlet structure.

Sediment trap Design Example

Given: A sediment trap designed for a 10-year, 24-hour storm is to be constructed on a development site as a temporary sediment control measure for a 3-acre drainage area that is totally disturbed.

The outlet is to be a rock fill constructed of rock with a mean diameter of 0.5-feet.

The soil is a Cecil sandy loam, the slope of the watershed is 5 percent, and the time of concentration is 6 minutes.

Find: If the desired trapping efficiency is 80 percent, what is the required peak discharge for trap areas of 0.10, 0.25, and 0.50 acres.

Solution:

1. Determine the Sediment Trap Ratio. From the Sediment Trap Design Aid (Figure ST1), the ratio for a design trapping efficiency of 80 percent is 9.0E4 ft^2/acre.

2. Determine the ratio of qpo/A required from the Sediment Trap Ratio,

$$\textit{Sediment Trap Ratio} = 9.0x10^4 = qpo/A*V_{15}$$

3. The D_{15} for a Cecil soil is 0.0066 mm, and the corresponding V_{15} for a Cecil sandy loam soil is 1.2E-4 ft/sec. Hence,

$$9.0x10^4\ V_{15} = qpo/A = (9.0x10^4)(1.2x10^{-4}) = 11 \text{ cfs /acre of pond.}$$

4. Determine qpo/A values. The following results are tabulated for the acreage shown:

Sediment Trap Bottom Area (acres)	qpo Through Rock Fill (cfs)
0.10	1.1
0.25	2.8
0.50	5.5

Each of these combinations will give the desired resulting 80 percent trapping efficiency.

The rock fill outlet structure must be designed to convey a peak flow of that shown in column two of the table above. See Section 6.4 for design details. If the check rock fill overtops, the trapping efficiency is assumed to be zero.

Sediment Trap

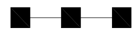
Sediment Trap

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Outlet spillway is clogged with the debris.	Remove debris by lightly raking debris from upstream side of spillway. If debris is excessive, remove smaller filter stone on upstream side of spillway and replace with new clean stone.
Spillway erodes due to high velocity flows.	Stabilize outlet with larger riprap on downstream side of spillway.
Side Slope eroding.	Stabilize slopes with vegetation, ECB, TRM, riprap or equivalent method.
Excessive accumulated sediment buildup.	Remove sediment to maintain sediment storage capacity.
Drainage area is too large.	Limit the contributing drainage area by installing diversion ditches and adding additional BMPs to accommodate the diverted flow.

Silt Fence

Plan Symbol



Description

Silt fence is used as a temporary perimeter control around sites where there will be soil disturbance due to construction activities. Silt fence consists of geotextile fabric stretched across steel posts. The lower edge of the fence is vertically trenched into the ground and covered by compacted backfill.

When and Where to Use It

Silt fence is applicable in areas:

- Where the maximum sheet or overland flow path length to the fence is 100-feet.
- Where the maximum slope steepness (normal [perpendicular] to fence line) is 2H:1V.
- That do not receive concentrated flows greater than 0.5 cfs.
- ¼ acre drainage per 100 linear feet

Do not place silt fence across channels or use it as a velocity control BMP.

Materials

Steel Posts

Use 48-inch long steel posts that meet the following minimum physical requirements:

- Composed of high strength steel with minimum yield strength of 50,000 psi.
- Have a standard “T” section with a nominal face width of 1.38-inches and nominal “T” length of 1.48-inches.
- Weigh 1.25 pounds per foot (± 8%).
- Have a soil stabilization plate with a minimum cross section area of 17-square inches attached to the steel posts.
- Painted with a water based baked enamel paint.

Use steel posts with a minimum length of 4-feet, weighing 1.25 pounds per linear foot (± 8%) with projections to aid in fastening the fabric. Except when heavy clay soils are present on site, steel posts will have a metal soil stabilization plate welded near the bottom such that when the post is driven to the proper depth, the plate will be below the ground level for added stability. The soil plates should have the following characteristics:

- Be composed of minimum 15 gauge steel.
- Have a minimum cross section area of 17-square inches.

Geotextile Filter Fabric

Filter fabric is:

- Composed of fibers consisting of long chain synthetic polymers composed of at least 85% by weight of polyolefins, polyesters, or polyamides.
- Formed into a network such that the filaments or yarns retain dimensional stability relative to each other.
- Free of any treatment or coating which might adversely alter its physical properties after installation.
- Free of defects or flaws that significantly affect its physical and/or filtering properties.
- Cut to a minimum width of 36 inches.

Use only fabric appearing on SCDOT Approval Sheet #34 meeting the requirements of the most current edition of the SCDOT Standard Specifications for Highway Construction.

Silt Fence Design Criteria

Design Aids

The Design Aids located in this section may be used to properly size silt fence. Sedimot III, SEDCAD4, and other computer models that utilize eroded particle size distributions and calculates a corresponding trapping efficiency may also be utilized. See Figure SF-1 for silt fence trapping efficiency.

General Design Requirements

a. 80 percent design removal efficiency goal for TSS
b. Maximum Slope Length - 100-feet
c. Maximum Slope Gradient – 2H:1V
d. Minimum Installed Fence Fabric Height – 18-inches
e. Maximum Installed Fence Fabric Height – 24-inches (exception for tidal areas)
f. Minimum Post Bury Depth – 18-inches
g. Maximum Post Spacing – 6-feet

Installation

Leave 10 feet between silt fence and creek or wetland.

Excavate a trench approximately 6-inches wide and 6-inches deep when placing fabric by hand. Place 12-inches of geotextile fabric into the 6-inch deep trench, extending the remaining 6-inches towards the upslope side of the trench. Backfill the trench with soil or gravel and compact.

Bury 12-inches of fabric into the ground when pneumatically installing silt fence with a slicing method.

Purchase fabric in continuous rolls and cut to the length of the barrier to avoid joints. When joints are necessary, wrap the fabric together at a support post with both ends fastened to the post, with a 6-inch minimum overlap.

Install steel posts to a minimum depth of 24-inches. Install steel posts a minimum of 1- to 2- inches above the fabric, with no more than 3-feet of the post above the ground. Space posts to maximum 6-feet centers.

Attach fabric to the steel posts using heavy-duty plastic ties that are evenly spaced and placed in a manner to prevent sagging or tearing of the fabric. In call cases, ties should be affixed in no less than 4 places.

Install the fabric a minimum of 24-inches above the ground. When necessary, the height of the fence above ground may be greater than 24-inches. In tidal areas, extra silt fence height may be required.
The post height will be twice the exposed post height. Post spacing will remain the same and extra height fabric will be 4-, 5-, or 6-feet tall.

Locate silt fence checks every 100 feet maximum and at low points.

Install the fence perpendicular to the direction of flow and place the fence the proper distance from the toe of steep slopes to provide sediment storage and access for maintenance and cleanout.

Height of Fill (ft)	Fill Slope	Minimum Silt Fence Offset from Toe of Slope (ft)	Minimum right of Way Offset From Toe of Slope (ft)
< 6	2:1 4:1 6:1	2	3
6-10	2:1	12*	13*
	4:1 6:1	3	4
>10	2:1	12*	13*
	4:1 6:1	4	5

*These minimum offsets may be reduced when curb and gutter or some other feature reduces the flow of water down the slope. The smaller offsets of each group of height of fill can not be reduced.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation. Check for sediment buildup and fence integrity. Check where runoff has eroded a channel beneath the fence, or where the fence has sagged or collapsed by fence overtopping.
- If the fence fabric tears, begins to decompose, or in any way becomes ineffective, replace the section of fence immediately.
- Remove sediment accumulated along the fence when it reaches 1/3 the height of the fence, especially if heavy rains are expected.
- Remove trapped sediment from the site or stabilize it on site.
- Remove silt fence within 30 days after final stabilization is achieved or after temporary best management practices (BMPs) are no longer needed.
- Permanently stabilize disturbed areas resulting from fence removal.

Silt Fence Design Aids

This design aid for applies to silt fences placed in areas down slope from disturbed areas where it serves to retard flow and cause settling. Two conditions must be met for satisfactory design:

- Trapping efficiency must meet the desired level of control, and
- Overtopping of the fence must not occur.

The silt fence design aid is a single line grouping all soil textures together. A similar procedure was used for development of the ratio as used for the ponds and rock checks. For the silt fence, the ratio is:

$$\text{Silt Fence Ratio} = \frac{q_{po}}{V_{15} P_{area}}$$

Where:

q_{po} = Peak outflow through the fence for the 10-year 24-hour storm event (cfs),
V_{15} = Characteristic settling velocity (fps), of the characteristic D_{15} eroded particle (mm),
P_{area} = Potential ponding area up slope of the fence (ft^2).

Estimate the ponding area by using the height of the fence available for flow through and extending a horizontal line from the fence to an intersection with the ground surface upslope of the fence. Calculate the unit available area by multiplying the fence height by the ground slope. Obtain the potential ponding area by multiplying this unit area by the available fence length.

Using the calculated ponding area, calculate the ratio and enter the value in Figure SF-1 to determine the trapping efficiency. Perform an overtopping calculation using the slurry flow rate through the fence. Check this rate against the incoming flow to determine if enough storage exists behind the fence preventing overtopping.

Constraints for the use of Silt Fence Design Aids:

- Watershed area is less than or equal to 5 acres
- Overland flow length is less than or equal to 500-feet
- Overland slope is less than or equal to 6 percent
- Slurry flow rate through the fence is less than or equal to 10 gpm/ft
- Maximum height of the silt fence is less than or equal to 3-feet

Silt Fence Ratios above the design curves are not recommended for any application of the design aids. If the silt fence ratio intersects the curve at a point having a trapping efficiency less than the desired value, the design is inadequate and must be revised.

A silt fence ratio equal to 0.23 has an 80 percent trapping efficiency as shown in Figure SF-1.

Silt Fence Design Examples

Given: Design a silt fence 1.5 ft-tall at the toe of a 2.0 percent slope draining a linear construction site.

Topography will cause runoff to drain through 400-feet of total fabric length.
Peak flow from the 1.0-acre upslope area is estimated at 2.5 cfs using the rational equation with "C" equal to 0.25 and intensity equal to 10.0 iph.

Slurry flow rate for the filter fabric is 10 gpm/ft^2 of fabric according to manufacturer specifications or other source.

Find: **(A)** The trapping efficiency if the soil is Lakeland Sand with an eroded size distribution having a D_{15} equal to 0.0463 mm.

(B) The trapping efficiency if the soil is Cecil with an eroded size distribution having a D_{15} equal to 0.0066 mm.

Solution:

A:

1. The settling velocity V_{15} of the D_{15} particle (0.0463 mm) is read from Figure SV-1 as 5.1 E-3 ft/sec.

2. Estimate the ponded area using the geometry of the installation. With a fence length of 400 ft, maximum depth equal to 1.5 ft, and upstream slope of 2.0 percent, there will be ponded area of 75 ft^2/linear ft of fabric for a total ponded area of:

$$P_{area} = (75\ ft^2/ft)\ (400\ ft) = 30{,}000\ ft^2$$

   The geometry calculates a required tie back of 75-feet to provide an adequate ponding area.

3. The silt fence ratio is calculated as:

$$\text{Silt Fence Ratio} = q_{po} / (V_{15}\ P_{area}) = 2.5/[(5.1E\text{-}3)(30{,}000)] = 0.017$$

4. Reading the trapping efficiency from the Silt Fence Design Aid (Figure SF-1) with the ratio equal to 0.017, the trapping efficiency is approximately **<u>94 percent</u>**.

- Check the fence for its ability to pass the design flow without overtopping.

5. Convert the peak flow from cfs to gpm:

$$q_{po} = (2.5\ ft^3/sec)(7.48\ gal/ft^3)(60\ sec/min) = 1122\ gpm$$

6. Divide the peak flow rate by the effective height (1.5-ft) and the slurry flow rate of 10 gpm/ft^2 of fabric to calculate the required fence length.

$$L = (1122)/\ (1.5)\ (10) = 75\ ft$$

7. 75 ft is less than the 400 ft available, so the fence will not overtop if it is properly maintained. Note: This analysis does not account for concentration of flows or strength of the posts, or fabric.

B.

1. A Cecil D_{15} topsoil is 0.0066 mm, and the settling velocity is found to be V_{15} = 1.2 E-4 fps.

2. The filter fence ratio is calculated as:

$$\text{Silt Fence Ratio} = q_{po} / (V_{15}\ P_{area}) = 2.5/[(1.2E\text{-}4)(30{,}000)] = 0.70$$

3. Reading the trapping efficiency from the Silt Fence Design Aid (Figure SF1) with the ratio equal to 0.70, the trapping efficiency is approximately **<u>70 percent.</u>**

Silt Fence

Silt Fence

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive sediment accumulation.	Remove sediment. Apply hydraulic mulch or straw mulch or other BMPs upstream to reduce eroded sediment.
Bottom of fence is not properly keyed in.	Dig trench, place fabric, and backfill.
Length of slope draining to silt fence is too long.	Shorten slope length using diversion ditches, additional silt fence runs, or other BMPs.
Storage capacity is inadequate due to sediment buildup.	Remove accumulated sediment when it reaches 1/3 the height of the barrier.
Lack of sufficient ponding area.	Install fence with at least a 5-feet setback from the toe of the slope where possible. Divert flow at top of slope with diversion ditches.
Erosion occurs around ends.	Turn ends into the up-slope area every 100 feet.
Silt fence is not installed along level contour.	Reinstall silt fence so that change in elevation does not exceed 1/3 the fabric height along the reach.
Slope draining to fence is too steep.	Shorten slope length using fiber rolls or equivalent. Increase setback of silt fence from the toe of slope.
Fence is installed in concentrated flow area.	Replace fence with proper BMP such as check dams, if appropriate.
Tie backs or j-hooks not installed or installed incorrectly.	Place Tie backs or j-hooks at a maximum separation of 100-feet.
Posts are too far apart.	Add stakes a maximum of 6-feet apart.
Concentrated flows causing erosion.	Place cross barrier check dams behind the silt fence.

Rock Check Dam

Plan Symbol

Description

A rock check dam is a small, temporary or permanent rock fill dam constructed across a drainage ditch, swale, or channel to lower the speed of concentrated flows. Design rock check dams to have an 80 percent design removal efficiency goal of the total suspended solids (TSS) in the inflow.

When and Where to Use It

Install rock check dams in steeply sloped swales, or in swales where adequate vegetation can not be established. Use rock check dams in small open channels. Do not place check dams in Waters of the State or USGS blue-line streams (unless approved by SCDHEC, State, or Federal authorities).

Rock Check Dam Design Criteria

Design Aids

The Design Aids located in this section (RC-C, RC-M, RC-F) may be used to properly size rock check dams. Sedimot III, SEDCAD4, and other computer models that utilize eroded particle size distributions and calculates a corresponding trapping efficiency may also be utilized.

General Design Requirements

a. 80 percent design removal efficiency goal for TSS
b. Maximum Drainage Area – 5 acres
c. Maximum Height – 2-feet
d. Spacing varies with the bed slope of the ditch. Space rock checks such that the toe of the upstream check is at the same elevation as the top of the downstream check.
e. If the rock check dam is not properly sized, the flow will overtop the structure and the Trapping Efficiency is assumed to be 0 percent when this failure takes place.

Installation

Install the center section of the rock check lower than the edges.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- Inspect for sediment and debris accumulation.
- Inspect rock check dam edges for erosion and repair promptly as required.
- Remove sediment when it reaches 1/3 the original check height.
- In the case of grass-lined ditches and swales, remove rock check dams when the grass has matured sufficiently to protect the ditch or swale unless the slope of the swale is greater than 4 percent.
- After construction is complete, remove stone if vegetation is used for permanent stabilization.
- Seed and mulch the area beneath the rock ditch checks immediately after dam removal.

Rock Check Dam Design Aids

Design aids for rock check dams were developed similarly to those for ponds. Again, the D_{15} eroded particle size is used for the calculation of the characteristic settling velocity. The ratio for ditch checks is defined by:

The Rock Check Dam Design Aids have been designed for the following soil classifications:

- Coarse (sandy loam)
- Medium (silt loam)
- Fine (clay loam).

The design ratio should be less than or equal to the curve value at any given trapping efficiency.

$$\text{Rock Check Ratio} = \frac{Sq^{(1-b)}}{aV_{15}}$$

Where:

S = Channel slope (%),
q = Unit width flow through the check for the 10-year 24-hour storm event (cfs/ft),
V_{15} = Characteristic settling velocity (fps), of the characteristic D_{15} eroded particle (mm).
Coefficients *a* and Exponent *b* is interpolated from tables

Constraints for the use of Rock Check Dam Design Aids:

- Watershed area is less than or equal to 5 acres
- Overland flow length is less than or equal to 500-feet
- Overland slope is less than or equal to 15 percent
- Maximum depth of the ditch is less than or equal to 6-feet

Rock Check Ratios above the design curves are not recommended for any application of the design aids. If the Rock Check Ratio intersects the curve at a point having a trapping efficiency less than the desired value, the design is inadequate and must be revised.

A rock check dam located on coarse soils has a ditch check ratio equal to 1.10 E3 at 80 percent trapping efficiency as shown in Figure RC-C.

A rock check dam located on medium soils has a ditch check ratio equal to 5.80 E3 at 80 percent trapping efficiency as shown in Figure RC-M.

A rock check dam located on fine soils has a ditch check ratio equal to 1.20 E4 at 80 percent trapping efficiency as shown in Figure RC-F.

Rock Check Dam Design Examples

Given: Install a rock check dam with a channel slope of 1.0 percent in the Piedmont on an area having Cecil sandy loam soils with an eroded size distribution of medium texture.

The runoff coefficient "C" for the rational method is estimated as 0.4 with an intensity of 6.75 in/hr for the design storm.

Drainage area to the ditch check is 4.4 ac.

Average rock diameter of the ditch check is 0.10 m (4 in.).

Average width (perpendicular to flow) is 6.7 ft and ditch check length is 3.3 feet.

Find: The trapping efficiency for the rock ditch check.

Solution:

1. A Cecil D_{15} topsoil is 0.0066 mm, and the settling velocity is found to be V_{15} = 1.2 E-4 fps.

2. Peak flow is estimated from the given information by substituting into the rational formula so that:

$$q_p = C\ i\ A = 0.4\ (6.75)(4.4) = 11.9\ \text{cfs}$$

3. The flow rate should be converted to <u>flow per unit width</u> by dividing the peak flow by the check width to obtain the design q as

$$q = 11.9\ \text{cfs}/6.7\ \text{ft} = 1.78\ \text{cfs/ft}$$

4. Appropriate values of the coefficients a and b are interpolated from the table provided in the Design Aids Section of this Handbook.

- Rock diameter of 0.10 m
- Flow length of 1.0 m
  a = 4.13
  b = 0.6651

Substitute all values and calculate the ditch check ratio

$$Sq^{(1-b)}/a\ V_{15} = (1.0)(1.78^{(1-0.6651)})/(4.13)(1.2E\text{-}4) = 2448$$

5. Enter the Rock Check Dam Design Aids for medium texture soil (Figure RC-M) on the y-axis with Rock Check Ratio = 2.5E3, go to line and turn to the x-axis to read trapping efficiency.

6. Trapping efficiency equals 86 percent.

Note: The rock check dam must also be checked for overtopping since this is a common occurrence and results in total failure of the check. If the check overtops, the trapping efficiency is assumed to be zero.

Rock Check Dam

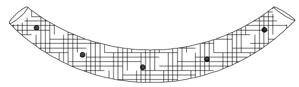
Rock Check Dam

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Too much sediment has accumulated.	Remove accumulated sediment to recover holding capacity.
There is insufficient ponding area.	Space check dams farther apart. Increase height of dam.
The check dam is higher than the drainage channel.	Lower check dam so that it is 6 inches lower than the channel side.
Check dams wash away.	Use larger stone for the body of the check dam. Decrease check dam spacing by adding more dams.
Wrong type of materials is used to construct check dam.	Use larger stones. Do not use straw bales or silt fence for checks.

Sediment Tubes

Plan Symbol



Description

Sediment tubes are elongated tubes of compacted geotextiles, curled excelsior wood, natural coconut fiber or hardwood mulch. Straw, pine needle, and leaf mulch-filled sediment tubes are not permitted.

When and Where to Use It

Install sediment tubes along contours, in drainage conveyance swales, and around inlets to help reduce the effects of soil erosion by energy dissipation and retaining sediment.

Materials

Sediment tubes for ditch checks and Type A Inlet Structure Filters exhibit the following properties:

- Produced by a Manufacturer experienced in sediment tube manufacturing.
- Composed of compacted geotextiles, curled excelsior wood, natural coconut fibers, hardwood mulch or a mix of these materials enclosed by a flexible netting material.
- Straw, straw fiber, straw bales, pine needles, and leaf mulch are not allowed under this specification.
- Utilizes outer netting that consists of seamless, high-density polyethylene photodegradable materials treated with ultraviolet stabilizers or a seamless, high-density polyethylene non-degradable materials.
- Diameter ranging from 18-inches to 24-inches.
- Curled excelsior wood, or natural coconut rolled erosion control products (RECPs) that are rolled up to create a sediment tube are **not** allowed under this specification.
- Select applicable Sediment Tubes from the SCDOT approved products list.

Installation

Proper site preparation is essential to ensure sediment tubes are in complete contact with the underlying soil or underlying surface. Remove all rocks, clods, vegetation or other obstructions so installed sediment tubes have direct contact with the underlying soil or surface.

Install sediment tubes by laying them flat on the ground. Construct a small trench to a depth that is 20% of the sediment tube diameter. Lay the sediment tube in the trench and compact the upstream sediment tube soil interface. Do not completely bury sediment tubes during installation. Review all project specifications for special installation requirements. Install sediment tubes so no gaps exist between the soil and the bottom of the sediment tube. Lap the ends of adjacent sediment tubes a minimum of 6-inches to prevent flow and sediment from passing through the field joint. Never stack sediment tubes on top of one another.

Avoid damage to sediment tubes during installation. Should the sediment tube become damaged during installation, place a stake on both sides of the damaged area terminating the tube segment and install a new tube segment. Perform field monitoring to verify that installation procedures do not damage sediment tubes. Replace all damaged sediment tubes damaged during installation as directed by the Inspector or Manufacturer’s Representative at the contractor's expense.

Install sediment tubes in swales or drainage ditches perpendicular to the water flow and extend them up the side slopes a minimum of 1-foot above the design flow depth. Space sediment tubes according to the following table.

Slope	Maximum Sediment Tube Spacing
Less than 2%	150-feet
2%	100-feet
3%	75-feet
4%	50-feet
5%	40-feet
6%	30-feet
Greater than 6%	25-feet

Install sediment tubes using wooden stakes (2-inch x 2-inch) or steel posts (standard "U" or "T" sections with a minimum weight of 1.25 pounds per foot) a minimum of 48-inches in length placed on 2-foot centers. Intertwine the stakes with the outer mesh on the downstream side, and drive the stakes in the ground to a minimum depth of 24-inches leaving less than 12-inches of stake above the exposed sediment tube.

An acceptable alternative installation is driving stakes on 2-foot centers on each side of the sediment tube and connecting them with natural fiber twine or steel wire to inhibit the non-weighted sediment tube from moving vertically. Sediment tubes can also be secured by installing the stakes on 2-foot centers in a crossing manner ensuring direct soil contact at all times.

Select the sediment tube check length to minimize the number of sediment tubes needed to span the width of the drainage conveyance. If the required length (perpendicular to the water flow) is 15-feet, then one 15-foot sediment tube is preferred compared to two overlapping 10-foot sediment tubes.

Install sediment tubes for ditch checks over bare soil, mulched areas, or erosion control blankets. Keep sediment tubes for ditch checks in place until fully established vegetation and root systems have completely developed and can survive on their own.

Inspection and Maintenance

- Inspect sediment tubes after installation for gaps under the sediment tubes and for gaps between the joints of adjacent ends of sediment tubes.
- Inspect every 7-days and within 24-hours of a rainfall event of 0.5-inches or greater.
- Repair all rills, gullies, and undercutting near sediment tubes.
- Remove all sediment deposits that impair the filtration capability of sediment tubes when the sediment reaches 1/3 the height of the exposed sediment tube.
- Remove and/or replace installed sediment tubes as required to adapt to changing construction site conditions.
- Remove sediment tubes from the site when the functional longevity is exceeded as determined by the Engineer, Inspector or Manufacturer's Representative. Gather sediment tubes and dispose of them in regular means as non-hazardous, inert material.
- Prior to final stabilization, backfill all trenches, depressions and other ground disturbances caused by the removal of sediment tubes.

Sediment Tube Check Dam

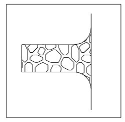
Sediment Tube Check Dam

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Too much sediment has accumulated.	Remove accumulated sediment to recover holding capacity. Remove accumulated sediment from the upstream side of the sediment tube when the sediment has reached a height of approximately one-third the original height of the tube (measured at the center).
There is insufficient ponding area.	Space sediment tubes farther apart or increase the sediment tube diameter.
Sediment tube washes away.	Use larger sediment tubes. Decrease post spacing, and add more posts. Install posts on both the upstream and downstream sides of the sediment tube. Decrease sediment tube spacing by adding more sediment tube check dams.
Other application used instead of sediment tubes	Do not use straw bales or silt fence as sediment tube check alternatives. In some situation rock check dams may be used as a sediment tube alternative.
Wrong type of materials or wrong type of sediment tube utilized.	Straw, pine needle and leaf mulch-filled sediment tubes are not permitted. Curled excelsior wood, or natural coconut rolled erosion control products (RECPs) that are rolled up to create a sediment tube are **not** permitted. Do not use straw bales or silt fence for checks.

Stabilized Construction Entrance

Plan Symbol



Description

A stabilized construction entrance is a temporary stone-stabilized pad located at all points of vehicular ingress and egress on a construction site to reduce the amount of mud, dirt, and rocks transported onto public roads by motor vehicles equipment and runoff.

When and Where to Use It

Use stabilized construction entrances whenever repetitive traffic will be leaving a construction site and moving directly onto a public road. Construction entrances provide an area where mud is removed from vehicle tires before entering a public road.

General Design Requirements

a. Minimum Entrance Dimensions
   1. Thickness = 6-inches
   2. Width of entrance area = 24-feet
   3. Length = 100-feet or required length for 10 tire revolutions
b. Material consisst of stone with a D_{50} diameter ranging from 2 to 3 inches.
c. Non-woven geotextile fabric is required to underlie the stone.

Installation

Remove all vegetation and any objectionable material from the foundation area.

Divert all surface runoff and drainage from stones to a sediment trap or basin.

Install a non-woven geotextile fabric prior to placing any stone.

Install a culvert pipe across the entrance when needed to provide positive drainage.

The entrance consists of 2 to 3 inch D_{50} aggregate with a minimum thickness of 6-inches.

Minimum dimensions of the entrance are 24-feet wide by 100-feet long, and may be modified as necessary to accommodate site constraints.

Taper the edges of the entrance out towards the road to prevent tracking of mud at the edge of the entrance.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation, or after heavy use.
- Check for mud and sediment buildup and pad integrity.
- Make daily inspections during periods of wet weather. Maintenance is required more frequently in wet weather conditions. Reshape the stone pad as needed for drainage and runoff control.
- Wash or replace stones as needed.

- Wash or replace he stone in the entrance whenever the entrance fails to reduce mud being carried off site by vehicles. Frequent washing will extend the useful life of stone.
- Immediately remove mud and sediment tracked or washed onto public roads by brushing or sweeping.
- Only use flushing when the water is discharged to a sediment trap or basin.
- Repair any broken pavement immediately.
- Inspect and clean sediment traps immediately following each rainfall.
- Dispose of sediment in a suitable area in such a manner that it will not erode.
- Remove as soon as they are no longer needed to provide access to the site. Bring the disturbed area to grade, and stabilize it using appropriate permanent stabilization methods.

Construction Entrance

Construction Entrance

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Access points require constant maintenance.	Select proper stabilization material or consider alternate methods for longevity, performance and site conditions.
Stone is tracked onto roadway.	Limit larger vehicles from construction exit or use larger diameter material.
Aggregate material is being incorporated into the soil.	Use geotextile fabric under base material.
Excessive sediment is tracked onto roadway.	Increase length of stabilized exit. Regularly maintain access area to remove sediment buildup.
Sediment-laden water is leaving the construction site.	Properly grade access points to prevent runoff from leaving site. Route runoff through a sediment-trapping device.
Sediment is being tracked from numerous locations.	Limit the number of access points and require their use. Stabilize designated access points.

Storm Drain Inlet Protection

Description

Storm drain inlet protection is achieved by placing a temporary filtering device around any inlet to trap sediment. This mechanism prevents sediment from entering inlet structures. Additionally, it serves to prevent the silting-in of inlets, storm drainage systems, or receiving channels.

There are six (6) types of inlet structure filters, including:

- Type A-Low Flow
- Type B-Medium Flow, Low Velocity
- Type C-Medium Flow, Medium Velocity
- Type D-High Flow, High Velocity
- Type E-Surface Course Curb Inlet
- Type F-Inlet Tubes

When and Where to Use It

Inlet protection may be installed prior to the construction of roads however, once the sub base is placed, a different type of inlet protection may be required. Inlet protection is required on all inlets that have outfalls that bypass sediment trapping structures and directly discharge off site. Use inlet protection as a last resort for sediment control when no other means are practical and do not use as the only means of protection.

General Design Requirements

Type A-Low Flow Inlet Filters include filter fabric inlet protection and 18-inch diameter sediment tubes

- Applicable for inlets with peak flow rates **less than 1 cfs** where the inlet drain area has grades less than 5%. The immediate drainage area (5-foot radius around the inlet) has grades less than 1%. Areas receiving concentrated flows **are not** acceptable.

Type B-Medium Flow, Low Velocity Inlet Filters include hardware fabric and stone inlet protection.

- Applicable for inlets with peak flow rates **less than 3 cfs** where the inlet drain area has grades **less than 5%.** Flow velocities to the inlet may **not exceed 3 feet per second**. Applicable where an overflow capacity is **not** required to prevent excessive ponding around the structure.

Type C-Medium Flow, Medium Velocity Inlet Filters include block and gravel inlet protection.

- Applicable for inlets with peak flow rates **less than 3 cfs** where the inlet drain has grades **less than 5%.** Flow velocities to the inlet may **not exceed 5 feet per second**. Applicable where an overflow capacity is required to prevent excessive ponding around the structure. **Not applicable in areas exposed to traffic**, such as median drains

Type D-Rigid Inlet Filters include prefabricated inlet filters composed of a geotextile fabric connected to a rigid structure

- Applicable for drainage areas up to **2 acres** with peak flow rates **greater than 3 cfs** where the inlet drain area has grades **greater than 5%**. Flow velocities to the inlet may **exceed 3 feet per second**.
- These filters are used for median applications (Type D1) and for sump applications (Type D2). Applicable where an overflow capacity **is** required to prevent excessive ponding around the structure. Capable of protecting inlet structures not associated with curb inlets. The inlets may include, but are not limited to yard inlets, DI 24-inches by 24-inches, DI 24-inches by 36-inches and manholes.

Type E-Surface Course Curb Inlet Filters include prefabricated inlet filters composed of a synthetic material that has aggregate compartments for stone, sand, or other weighted mechanisms to hold the unit in place.

- Applicable for roadway catch basins after the road surface course is placed

Type F-Inlet Tubes are classified in two categories: weighted inlet tubes and non-weighted inlet tubes.

- Weighted inlet tubes are applicable for inlets with drainage areas less than 1 acre. Weighted inlet tubes are used for placement on gravel, concrete, asphalt or other hard surfaces around drainage inlets where stakes cannot be driven. Weighted inlet tubes are applicable where construction traffic may occur around the inlet. All weighted Type F Inlet Structure Filters are applicable as Type E Inlet Structure Filters.

- Non-weighted inlet tubes are inlet tubes applicable for Catch Basins with drainage areas less than 1 acre where stakes or posts are driven to hold the tube in place. For non-weighted inlet tube applications, an inlet tube is placed on subgrade and is applicable until the road base course is placed.

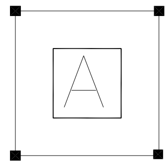
- Both weighted and non-weighted inlet tubes are applicable as weep hole inlet filters, although non-weighted inlet tubes can only be used in situations where stakes is driven into the ground or subgrade to secure the tube.

General Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each storm that produces ½-inches or more of rain. Handle any damage or needed repairs immediately.
- Inspect after installation for gaps that may permit sediment to enter the storm drainage system.
- Remove accumulated sediment and debris from the surface and vicinity of Inlet Filters after each rain event or as directed by the Engineer, Inspector or Manufacturer's Representative.
- Remove sediment when it reaches approximately 1/3 the height of the Inlet Filter. If a sump is used, remove sediment when it fills approximately 1/3 the depth of the hole. Maintain the pool area, always providing adequate sediment storage volume for the next storm event.
- Remove, move, and/or replace as required to adapt to changing construction site conditions.
- Remove Inlet Filters from the site when the functional longevity is exceeded as determined by the Engineer, Inspector or Manufacturer's Representative.
- Dispose of Inlet Filters no longer in use at an appropriate recycling or solid waste facility.
- Prior to final stabilization, backfill and repair all trenches, depressions, and other ground disturbances caused by the removal of Inlet Filters.
- Remove all construction material and sediment and dispose of them properly. Grade the disturbed areas to the elevation of the inlet structure crest. Stabilize all bare areas immediately.

Type A – Filter Fabric Inlet Protection

Plan Symbol



Design filter fabric inlet protection to have an 80 percent design removal efficiency goal of the total suspended solids (TSS) in the inflow. The Design Aids located in the Silt Fence section of this Handbook may be used to properly design filter fabric inlet protection.

Materials

Use filter fabric that conforms to SCDOT standard specifications for highway construction (latest edition). Refer to the silt fence geotextile fabrics SCDOT Approval Sheet #34.

Use 48-inch long wood posts that meet the following requirements.

- 2-inch by 2-inch size.
- Heavy-duty wire staples at least 1½-inch long, spaced a maximum of 6-inches apart to attach the filter fabric to wooden stakes.

Use 48-inch long steel posts that meet the following minimum physical requirements:

- Be composed of high strength steel with minimum yield strength of 50,000 psi.
- Have a standard “T” section with a nominal face width of 1.38-inches and nominal “T” length of 1.48-inches.
- Weigh 1.25 pounds per foot (± 8%).
- Be painted with a water based baked enamel paint.

Installation

Excavate a trench 6-inches wide and 6-inches deep around the outside perimeter of the inlet.

Extend the filter fabric a minimum of 12-inches into the trench. Backfill the trench with soil or crushed stone and compact over the filter fabric unless the fabric is pneumatically installed.

Install the filter fabric to a minimum height of 18-inches and maximum height of 24-inches above grade. Space the posts around the perimeter of the inlet a maximum of 3-feet apart and drive them into the ground a minimum of 24-inches.

Cut the filter fabric from a continuous roll to the length of the protected area to avoid the use of joints. When joints are necessary, wrap filter fabric together only at a support post with both ends securely fastened to the post, with a minimum 6-inch overlap.

Attach fabric to wood posts using heavy-duty wire staples at least 1½-inch long, spaced a maximum of 6-inches apart.

Attach fabric to steel posts with heavy-duty plastic ties. Attach at least four (4) evenly spaced ties in a manner to prevent sagging or tearing of the fabric. In all cases, affix ties in no less than four (4) places.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation. Replace the fabric if it becomes clogged.
- Remove the sediment when it reaches 1/3 the height of the fabric. Take care not to damage or undercut fabric when removing sediment.
- If a sump is used, remove sediment when it fills 1/3 the depth of the hole.
- Maintain the pool area, always providing adequate sediment storage volume for the next storm.
- Remove storm drain inlet protection only after the disturbed areas are permanently stabilized.
- Remove all construction material and sediment, and dispose of them properly.
- Grade the disturbed area to the elevation of the drop inlet structure crest. Use appropriate permanent stabilization methods to stabilize bare areas around the inlet.

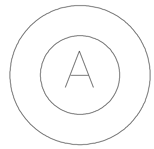
Filter Fabric Inlet Protection

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive sediment entering inlet.	Ensure that soil stabilization and sediment control devices are installed upstream of inlets. Ensure that the barriers around the inlet are installed correctly. Filter fence needs to be keyed in so that water goes through filter fabric and not under it. Use a different type of inlet protection if concentrated flows are observed.
Filter fabric clogged by sediment or other debris.	Replace filter fabric.
Sediment reaches 1/3 the height of fabric.	Remove sediment.
Ponded water causes a traffic concern.	Use alternate BMPs upstream. Remove inlet protection if necessary.

Type A – Sediment Tube Inlet Protection

Plan Symbol



Materials

Sediment tubes for Type A Inlet Structure Filters exhibit the following properties:

- Produced by a Manufacturer experienced in sediment tube manufacturing.
- Composed of compacted geotextiles, curled excelsior wood, natural coconut fibers, hardwood mulch or a mix of these materials enclosed by a flexible netting material.
- Straw, straw fiber, straw bales, pine needles, and leaf mulch are not allowed under this specification.
- Utilizes outer netting that consists of seamless, high-density polyethylene photodegradable materials treated with ultraviolet stabilizers or a seamless, high-density polyethylene non-degradable materials.
- Diameter ranging from 18-inches to 24-inches.
- Curled excelsior wood, or natural coconut rolled erosion control products (RECPs) that are rolled up to create a sediment tube are **not** allowed under this specification.
- Select applicable Sediment Tubes from the SCDOT approved products list.

Use 48-inch long wood posts that meet the following requirements.

- 2-inch by 2-inch size.
- Heavy-duty wire staples at least 1½-inch long, spaced a maximum of 6-inches apart to attach the filter fabric to wooden stakes.

Use 48-inch long steel posts that meet the following minimum physical requirements:

- Be composed of high strength steel with minimum yield strength of 50,000 psi.
- Have a standard "T" section with a nominal face width of 1.38-inches and nominal "T" length of 1.48-inches.
- Weigh 1.25 pounds per foot (± 8%).
- Be painted with a water based baked enamel paint.

Installation:

Remove all rocks, clods, vegetation or other obstructions so installed sediment tubes have direct contact with the underlying soil or surface.

Install sediment tubes by laying them flat on the ground. Construct a small trench to a depth that is 20% of the sediment tube diameter. Lay the sediment tube in the trench and compact the upstream sediment tube soil interface. Do not completely bury sediment tubes during installation. Lap the ends of adjacent sediment tubes a minimum of 6-inches to prevent flow and sediment from passing through the field joint. Never stack sediment tubes on top of one another.

Install sediment tubes using wooden stakes (2-inch x 2-inch) or steel posts (standard "U" or "T" sections with a minimum weight of 1.25 pounds per foot) a minimum of 48-inches in length placed on 2-foot centers. Intertwine the stakes with the outer mesh on the downstream side, and drive the stakes in the ground to a minimum depth of 24-incest leaving less than 12-inches of stake above the exposed sediment tube.

Inspection and Maintenance:

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- Inspect sediment tubes after installation for gaps under the tubes and for gaps between joints of adjacent ends of sediment tubes. Repair rills, gullies, and all undercutting near sediment tubes.
- Remove and/or replace installed sediment tubes as required to adapt to changing construction site conditions.
- Remove all sediment tubes from the site when the functional longevity is exceeded as determined by the Engineer, Inspector or Manufacturer's Representative.
- Dispose of sediment tubes in regular means as non-hazardous, inert material.

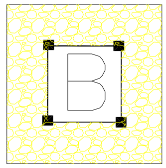
Sediment Tube Inlet Protection

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Too much sediment has accumulated.	Remove accumulated sediment to recover holding capacity. Remove accumulated sediment from the upstream side of the sediment tube when the sediment has reached a height of approximately one-third the original height of the tube (measured at the center).
Sediment tube washes away.	Use larger sediment tubes. Decrease post spacing, and add more posts. Install posts on both the upstream and downstream sides of the sediment tube.
Other application used instead of sediment tubes	Do not use straw bales as sediment tube alternatives.
Wrong type of materials or wrong type of sediment tube utilized.	Straw, pine needle and leaf mulch-filled sediment tubes are not permitted. Curled excelsior wood, or natural coconut rolled erosion control products (RECPs) that are rolled up to create a sediment tube are **not** permitted. Do not use straw bales.

Type B - Hardware Fabric and Stone Inlet Protection

Plan Symbol



Design hardware fabric and stone inlet protection to have an 80 percent design removal efficiency goal of the total suspended solids (TSS) in the inflow. The Design Aids located in the Rock Check Dam section of this Handbook may be used to properly design hardware fabric inlet protection.

Materials

Use hardware fabric or comparable wire mesh with maximum openings of 0.5-inches x 0.5-inches as the supporting material.

Use48-inch steel posts that meet the following minimum physical requirements:

- Be composed of high strength steel with minimum yield strength of 50,000 psi.
- Have a standard "T" section with a nominal face width of 1.38-inches and nominal "T" length of 1.48-inches.
- Weigh 1.25 pounds per foot (± 8%).
- Be painted with a water based baked enamel paint.

Use heavy-duty wire ties to attach the wire mesh material to the steel posts.

Place Aggregate No. 5 washed stone against the hardware fabric on all sides.

Installation

Excavate a trench 6-inches deep around the outside perimeter of the inlet.

Use hardware fabric or comparable wire mesh with maximum openings of 0.5-inches by 0.5-inches as the supporting material. Extended the fabric a minimum of 6-inches into the ground. Backfill the trench with soil or crushed stone and compact over the fabric.

Use steel posts with a minimum post length of 48-inches consisting of standard "T" sections with a weight of 1.25 pounds per foot (±8%). Install the wire mesh fabric above grade a minimum of 18-inches without exceeding 24-inches.

Space the steel posts a maximum of 3-feet apart around the perimeter of the inlet and drive them into the ground a minimum of 24-inches.

Use heavy-duty wire ties spaced a maximum of 6-inches apart to attach the wire mesh material to the steel posts.

Place Aggregate No. 5 washed stone to a minimum height of 12-inches, and a maximum height of 24-inches against the hardware fabric on all sides.

Inspection and Maintenance

- If the stone becomes clogged with sediment, pull the stones away from the inlet and clean or replace them.
- Since cleaning of gravel at a construction site may be difficult, an alternative approach would be to use the clogged stone as fill and put fresh stone around the inlet.

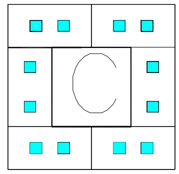
Hardware Fabric and Stone Inlet Protection

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive sediment is entering the inlet.	Ensure that soil stabilization and sediment control devices are installed upstream of inlets. Ensure that the barriers around the inlet are installed correctly.
Sediment reaches 1/3 the height of the structure.	Remove sediment.
Stone filter material becomes clogged with sediment.	Pull stones away from inlet and clean them, or replace them with new stones.
Ponded water causes a traffic concern.	Use alternate BMPs upstream. Remove drain inlet protection if necessary.

Type C - Block and Gravel Inlet Protection

Plan Symbol



Block and gravel filters are used where heavy flows and higher velocities are expected and where an overflow capacity is necessary to prevent excessive ponding around the structure.

Materials

Use masonry blocks ranging from 8 to 12 inches wide.

Use hardware fabric or comparable wire mesh with maximum openings of ½-inches x ½-inches as the supporting material.

Use 1-inch D_{50} washed stone gravel.

Installation

Place the bottom row of the concrete blocks lengthwise on their side so that the open end faces outward, not upward.

The height of the barrier is varied, depending upon design needs by stacking a combination of blocks that are 8- and 12-inches wide.

Place wire mesh over the outside vertical face of the concrete blocks to prevent stones from being washed through the holes in the blocks. Use hardware cloth or comparable wire mesh with ½-inch x ½-inch openings.

Install 1-inch D_{50} washed stone to a height equal to the elevation of the top of the blocks.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each storm that produces ½-inches or more of rain. Any needed repairs should be handled immediately.
- Remove sediment when it reaches 1/3 the height of the blocks. If a sump is used, remove sediment when it fills 1/3 the depth of the hole.
- If the stone filter becomes clogged with sediment, the stones must be pulled away from the inlet and cleaned or replaced. Since cleaning of gravel at a construction site may be difficult, an alternative approach would be to use the clogged stone as fill and put fresh stone around the inlet.
- Remove inlet protection structures after the disturbed areas are permanently stabilized. Remove all construction material and sediment, and dispose of them properly.
- Grade the disturbed area to the elevation of the drop inlet structure crest.
- Stabilize all bare areas immediately.

Block and Gravel Inlet Protection

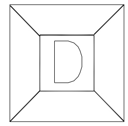
Block and Gravel Inlet Protection

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive sediment is entering the inlet.	Ensure that soil stabilization and sediment control devices are installed upstream of inlets. Ensure that the block and gravel inlet protection is installed correctly.
Sediment reaches 1/3 the height of the blocks.	Remove sediment.
Stone filter material becomes clogged with sediment.	Pull stones away from inlet and clean them, or replace them with new stones.
Ponded water causes a traffic concern.	Use alternate BMPs upstream. Remove inlet protection if necessary.

Type D – Rigid Inlet Filters

Plan Symbol



There are two uses for rigid inlet filters: median applications (Type D1) and sump applications (Type D2). Type D1 filters have more overflow capacity and less filtration area than Type D2 to prevent ponding in medians. These filters are capable of protecting inlet structures not associated with curb inlets

Materials

Rigid inlet filters exhibit the following properties:

- Composed of a geotextile fabric connected to a rigid structure. The geotextile fabric is non-biodegradable and resistant to degradation by ultraviolet exposure and resistant to contaminants commonly encountered in storm water.
- Use a rigid structure composed of high molecular weight, high-density polyethylene copolymer with a UV inhibitor. Do not use structures that are not reusable and recyclable.
- Use a filter fabric constructed of 100% continuous polyester non-woven engineering fabric. The filter fabric is fabricated to provide a direct fit adjacent to the associated rigid structure.
- Rigid inlet filters have a two-stage design. The first stage conveys normal flows at a minimum clean water flow rate of 100 gallons per minute per square foot. The second stage conveys high flow rates, with a minimum apparent opening of 0.5-inch per square inch (No. 12 standard sieve opening).
- Type D1 inlet filters have a first stage minimum height of 9-inches and a maximum height of 12-inches in order to allow greater overflow capacity and prevent ponding in the median.
- Rigid inlet filters completely surround the inlet.
- Rigid inlet filters have lifting devices or structures to assist in the installation and to allow inspection of the storm water system.
- The filter fabric is capable of reducing effluent sediment concentrations by no less than 80% under typical sediment migration conditions.
- Select applicable Type D inlet filters from the SCDOT approved products list.

Installation

Install rigid inlet filters in accordance with the Manufacturer's written installation instructions. Properly install rigid inlet protection so the inlet is completely enclosed.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each storm that produces ½-inches or more of rain. Any needed repairs should be handled immediately.
- Inspect after installation to insure that no gaps exist that may permit sediment to enter the storm drain system.
- Remove and/or replace rigid inlet filters to adapt to changing construction site conditions.
- Clean the rigid inlet protection filter material when it becomes covered or clogged with deposited sediment.
- Replace the rigid inlet protection filter material as directed by the Engineer.

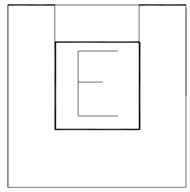
Rigid Inlet Filters

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive sediment is entering the inlet.	Ensure that soil stabilization and sediment control devices are installed upstream of inlets. Ensure that the rigid inlet filters are installed correctly.
Sediment reaches 1/3 the height of the structure.	Remove sediment.
Rigid inlet filter material becomes clogged with sediment.	Pull rigid inlet filters from inlet and clean them, or replace rigid inlet filters with new filter material.
Ponded water causes a traffic concern.	Use alternate BMPs upstream. Remove rigid inlet filter if necessary.

Type E - Surface Course Curb Inlet Filters

Plan Symbol



Materials

Use surface course inlet filters that have a minimum height or diameter of 9-inches and have a minimum length that is 2-feet longer than the length of the curb opening. Surface course inlet filters are not designed to completely block the inlet opening.

Use surface course inlet filters constructed with a synthetic material that will allow storm water to freely flow through while trapping sediment and debris. Use a material that is non-biodegradable and resistant to degradation by ultraviolet exposure and resistant to contaminants commonly encountered in storm water. Straw, straw fiber, straw bales, pine needles, and leaf mulch are not permissible filter materials.

Surface course inlet filters have aggregate compartments for stone, sand or other weighted materials or mechanisms to hold the unit in place.

Use filter fabric that is capable of reducing effluent sediment concentrations by no less than 80% under typical sediment migration conditions.

Select Type E inlet filters from the SCDOT approved products list.

Installation

Surface course inlet filters are applicable for road Catch Basin after the road surface course is placed. Place surface course inlet filters where sediment may spill over sidewalks and curbs.

Install surface course inlet filters in front of curb inlet openings. The filter has a minimum height or diameter of 9-inches and has a minimum length that is 2-feet longer than the length of the curb opening to allow sufficient length to cover the inlet with at least 1-foot of clearance beyond the inlet on both ends.

Do not completely block the inlet opening with surface course inlet filters. Install surface course inlet filters in a manner to allow overflows to enter the catch basin.

Fill the aggregate compartment to a level (at least ½ full) that will keep the surface course inlet filter in place and create a seal between the surface course inlet filter and the road surface.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each storm that produces ½-inches or more of rain. Any needed repairs should be handled immediately.
- Ponding is likely if sediment is not removed regularly.
- Inspect surface course curb inlet filters on a regular basis and immediately after major rain events.
- Clean the surface course curb inlet filter if a visual inspection shows silt and debris build up around the filter.

Surface Course Inlet Filter

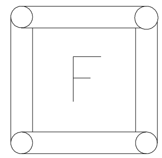
Surface Course Inlet Filter

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive sediment is entering the inlet.	Ensure that soil stabilization and sediment control devices are installed upstream of inlets. Ensure that the surface course inlet filters are installed correctly.
Sediment reaches 1/3 the height of the structure.	Remove sediment.
Surface course inlet filter material becomes clogged with sediment.	Pull surface course filters from inlet and clean them, or replace surface course inlet filters with new filter material.
Ponded water causes a traffic concern.	Use alternate BMPs upstream. Remove surface course inlet filter if necessary.

Type F - Inlet Tubes

Plan Symbol



Inlet tubes are temporary filtering devices placed around inlet structures to trap sediment and keep silt, sediment and construction debris from entering pipe systems through open inlet structures. Additionally, inlet tubes prevent the silting-in of inlets, storm drainage systems and receiving channels.

Materials

Use inlet tubes that exhibit the following properties:

- Produced by a Manufacturer experienced in sediment tube manufacturing.
- Composed of compacted geotextiles, curled excelsior wood, natural coconut fibers or hardwood mulch or a mix of these materials enclosed by a flexible netting material.
- Do not use straw, straw fiber, straw bales, pine needles or leaf mulch under this specification.
- Utilize an outer netting that consists of seamless, high-density polyethylene photodegradable materials treated with ultraviolet stabilizers or a seamless, high-density polyethylene non-degradable materials.
- Curled wood excelsior fiber, or natural coconut fiber rolled erosion control products (RECP) rolled up to create an inlet tube devices are **not** allowed under this specification.

Weighted Inlet Tubes

Weighted inlet tubes are sediment tubes capable of staying in place without external stabilization measures and may have a weighted inner core or other weighted mechanism to keep them in place.

Materials

Weighted inlet tubes meet the minimum performance requirements shown in the table below.

PROPERTY	TEST METHOD	VALUE
Diameter	Field Measured	6.0 inch to 12.0 inch
Mass per Unit Length	Field Measured	6 inch = 6 lbs/ft minimum 12 inch = 12 lbs/ft minimum
Fiber Length	Field Measured	80% of the fiber materials at least 4-inches in length
Length per Tube	Field Measured	6 foot minimum
Netting Unit Weight	Certified	0.35 oz/ft minimum

Select Type F weighted inlet tubes from the SCDOT approved products list.

Installation

Install weighted inlet tubes lying flat on the ground, with no gaps between the underlying surface and the inlet tube. Never stack weighted inlet tubes on top of one another.

Do not completely block inlets with weighted inlet tubes.

Install weighted inlet tubes in such a manner that all overflow or overtopping water has the ability to enter the inlet unobstructed.

To avoid possible flooding, two or three concrete cinder blocks may be placed between the weighted inlet tubes and the inlet.

Non-Weighted Inlet Tubes

Non-weighted inlet tubes are defined as sediment tubes that require staking or other stabilization methods to keep them safely in place.

Materials

Non-weighted inlet tubes meet the minimum performance requirements shown in the table below.

PROPERTY	TEST METHOD	VALUE
Diameter	Field Measured	6.0 inch to 12.0 inch
Mass per Unit Length	Field Measured	6 inch = 1.0 lbs/ft minimum 12 inch = 2.0 lbs/ft minimum
Fiber Length	Field Measured	80% of the fiber materials at least 4-inches in length
Length per Tube	Field Measured	6 foot minimum
Netting Unit Weight	Certified	0.35 oz/ft minimum

Select Type F non-weighted inlet tubes from the SCDOT approved products list.

Installation

Install non-weighted inlet tubes immediately after grading and construction of catch basin boxes. Maintain non-weighted inlet tubes during subgrade and base preparation until the base course is placed.

For weep hole inlet protection applications, both weighted and non-weighted inlet tubes are applicable. Install non-weighted inlet tubes in situations when stakes can be driven into the ground or subgrade to secure the tube.

Review all project specifications for special installation requirements.

Install non-weighted inlet tubes using 2-inch x 2-inch wooden stakes or steel posts consisting of standard "T" sections weighing 1.25 pounds per foot (±8%), 3-feet in length placed on 2-foot centers. Intertwine the stakes with the outer mesh on the downstream side of the inlet tube.

Drive stakes in the ground to a minimum depth of 1-foot leaving less than 1-foot of stake exposed above the non-weighted inlet tube.

An acceptable alternative installation is driving stakes on 2-foot centers on each side of non-weighted inlet tubes and connecting them with natural fiber twine or steel wire to inhibit the non-weighted sediment tube from moving vertically.

Another acceptable alternative installation for non-weighted inlet tubes is installing stakes on 2-foot centers in a crossing manner maintaining direct soil contact at all times.

Install non-weighted inlet tubes so the top of the tube is below the top of the installed curb line to ensure that all overflow or overtopping water has the ability to enter the inlet unobstructed.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each storm that produces ½-inches or more of rain. Any needed repairs should be handled immediately.
- Inlet tubes may be temporarily moved during construction as needed.
- Replace inlet tubes damaged during installation as directed by the Inspector or Manufacturer's Representative at the contractor's expense.

Weighted Inlet Tube

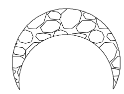
Non-weighted Inlet Tube

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive sediment is entering the inlet.	Ensure that soil stabilization and sediment control devices are installed upstream of inlets. Ensure that inlet tubes are installed correctly.
Sediment reaches 1/3 the height of the inlet tube.	Remove sediment.
Filter material becomes clogged with sediment.	Pull Inlet from tube and clean them, or replace clogged inlet tubes with inlet tubes
Ponded water causes a traffic concern.	Use alternate BMPs upstream. Remove inlet tubes if necessary.

Rock Sediment Dikes

Plan Symbol



Description

Rock sediment dikes are semi-circular sediment control structures constructed across drainage ditches, swales, low areas or other areas that receive concentrated flow. A rock sediment dike consists of a half-circular shaped rock embankment with a sump area constructed for sediment storage. Design rock sediment dikes to have an 80 percent design removal efficiency goal of the total suspended solids (TSS).

When and Where to Use It

Rock sediment dikes are most effective in areas where sediment control is needed with minimal disturbance. Use as a sediment control structures for the outfalls of diversion swales, diversion dikes, in low areas or other areas where concentrated sediment laden flow is expected. Use rock sediment dikes for drainage less than 2.0 acres. Do not place rock sediment dikes in Waters of the State (unless approved by SCDHEC, State, or Federal authorities).

Rock Sediment Dike Design Criteria

Design Aids

The Design Aids located in the rock check dam section of this handbook may be used to properly size rock sediment dikes. Sedimot III, SEDCAD4, Pond Pack and other computer models that utilize eroded particle size distributions and calculates a corresponding trapping efficiency may also be utilized.

General Design Requirements

a. Maximum Drainage Area – 2 acres
b. Maximum Design Life - 18 months
c. Maximum Rock Dike Height – 2-feet
d. Discharge and treatment capacity for the 10-year 24-hour storm event.
e. 80 percent design removal efficiency goal for TSS
f. Determine required sediment storage volume and ensure sediment dike sump provides the volume.
g. Size rock sediment dike to handle the receiving peak flow rates. Flows that overtop the structure have an assumed Trapping Efficiency of 0 percent.

Installation

Install a non-woven geotextile fabric over the soil surface where the rock sediment dike is to be placed.

Construct the body of the rock sediment dike with minimum 9-inch D_{50} Riprap. Construct the upstream face with a 1-foot thick layer of ¾-inch to 1-inch D_{50} washed stone placed at a slope of 2H:1V.

Construct rock sediment dikes with a minimum top flow length of 3-feet (two-foot flow length through the riprap and one-foot flow length through the washed stone).

Place the rock by hand or mechanical placement (no dumping of rock to form the sediment dike) to achieve the proper dimensions.

Install a sediment sump with a minimum depth of 2-feet on the upstream side of the structure to provide sediment storage. Install the upstream side of the sediment sump with a slope of 5H:1V to inhibit erosion of the sediment storage area.

Mark the sediment cleanout level of the sediment dike with a stake in the field.

Seed and mulch all disturbed areas.

Inspection and Maintenance

- The key to a functional rock sediment dike is continual monitoring, regular maintenance and regular sediment removal.
- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- Remove sediment when it reaches 50 percent of the sediment storage volume or the top of the cleanout stake. Removed sediment from the sump should be removed from, or stabilized on site.
- Remove rock sediment dikes within 30 days after final site stabilization is achieved or after they are no longer needed. Permanently stabilize disturbed areas resulting from the removal.

Rock Sediment Dike

Rock Sediment Dike

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Sediment reaches 50 percent of the sediment storage volume or the top of the cleanout stake.	Remove accumulated sediment to recover holding capacity.
Rock sediment dikes wash away.	Replace rock sediment dikes using larger stone.
Final site stabilization is achieved.	Remove rock sediment dikes from site within 30 days after stabilization, and permanently stabilize the areas that were disturbed by the dikes.